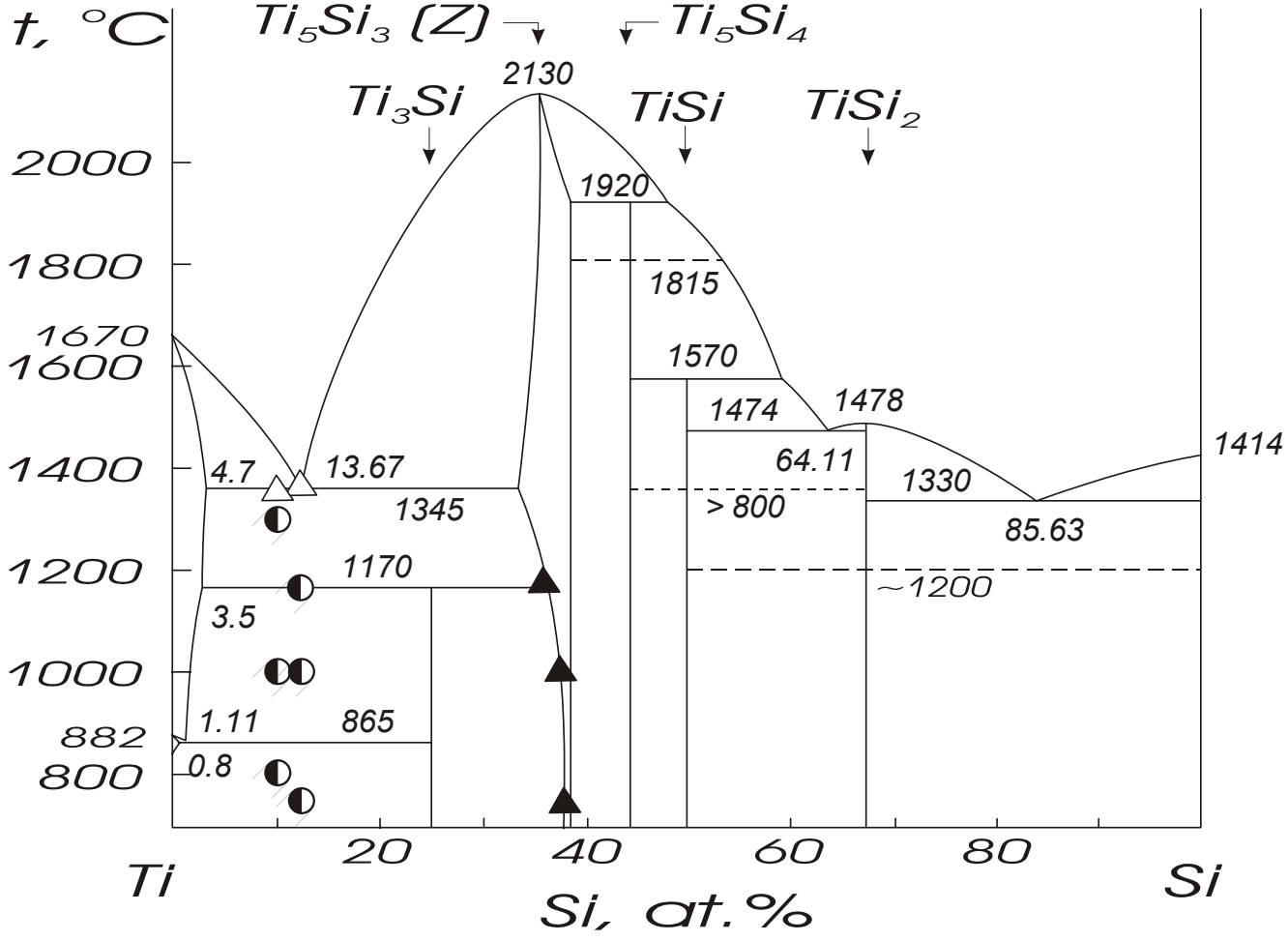
# MULTICOMPONENT Ti-Si-BASED SYSTEMS

**or**

# PHASE RELATIONSHIPS AND PROPERTIES OF MULTICOMPONENT Ti-Si-BASED ALLOYS AS FUNDAMENTAL BACKGROUND FOR ELABORATION OF HIGH-TEMPERATURE TITANIUM MATERIALS

M.Bulanova, S.Firstov, L.Kulak, D.Miracle, L.Tretyachenko and T.Velikanova



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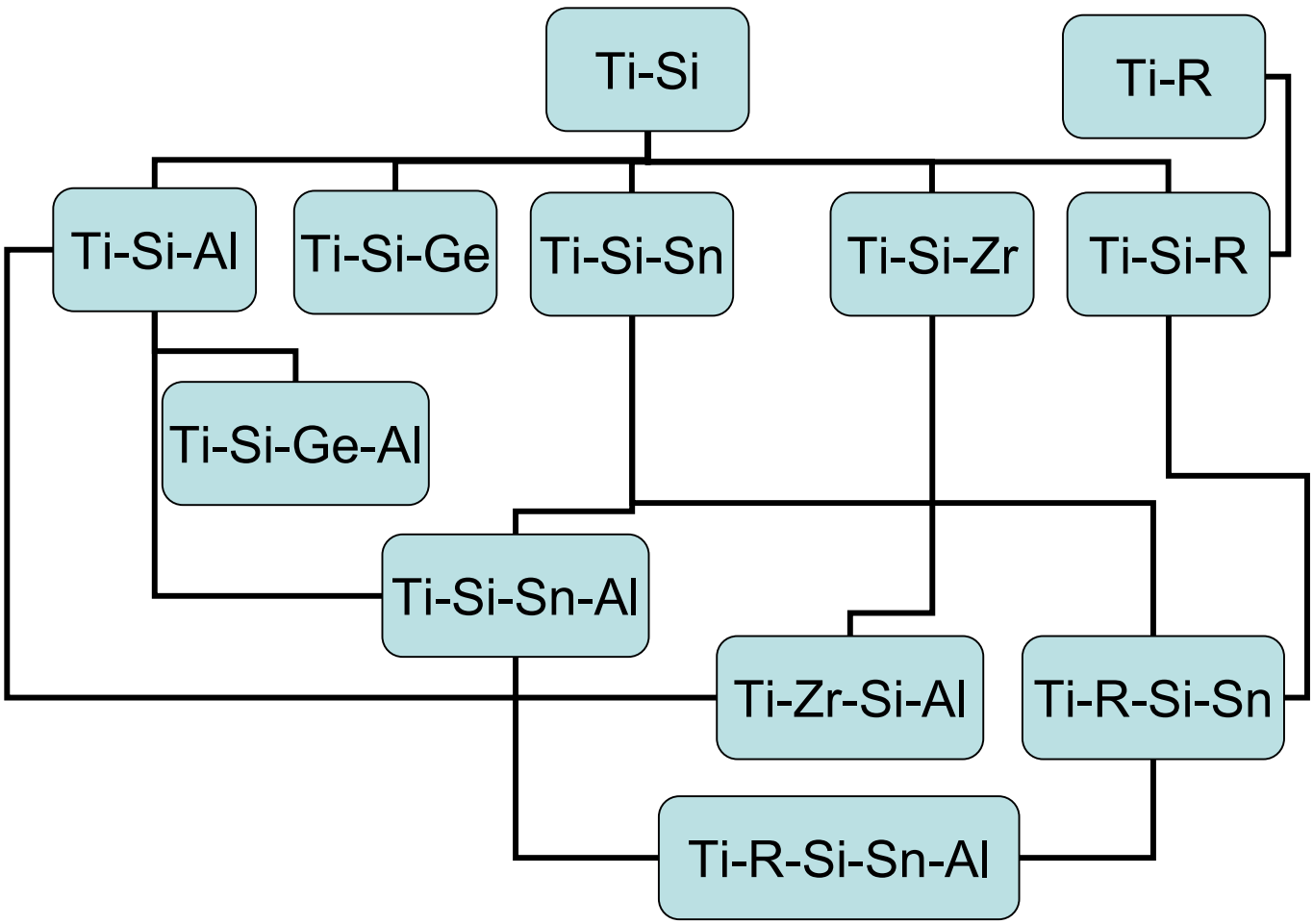
# Scheme of the presentation



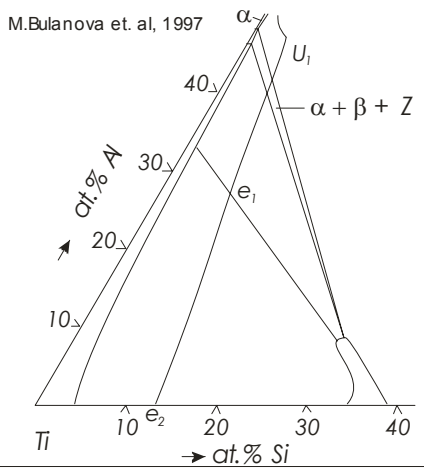

- Homogeneity ranges of the phases
- Eutectics:

  *extension of the binary eutectic into the multicomponent system*

  *search for new **binary** and **ternary** eutectics*
- Phase relationships in the solid state
- Links phase diagram - property

# Ti-corners of Ti-Si-p-element melting diagrams

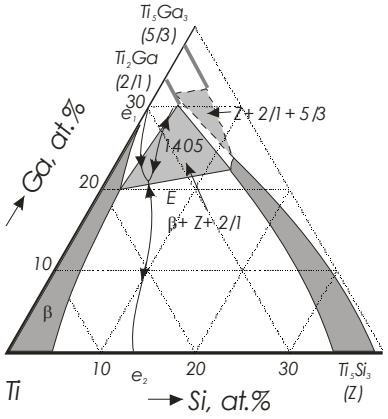
M.Bulanova et. al, 1997



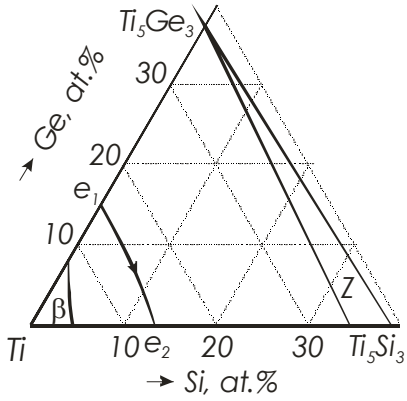

Two tendencies

1. Crystal structure of 5/3 binary intermetallics
2. Difference in atomic radii op the p-elements

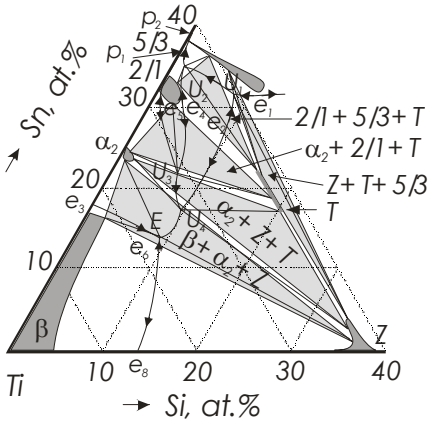
N.Antonova et. al, 1998



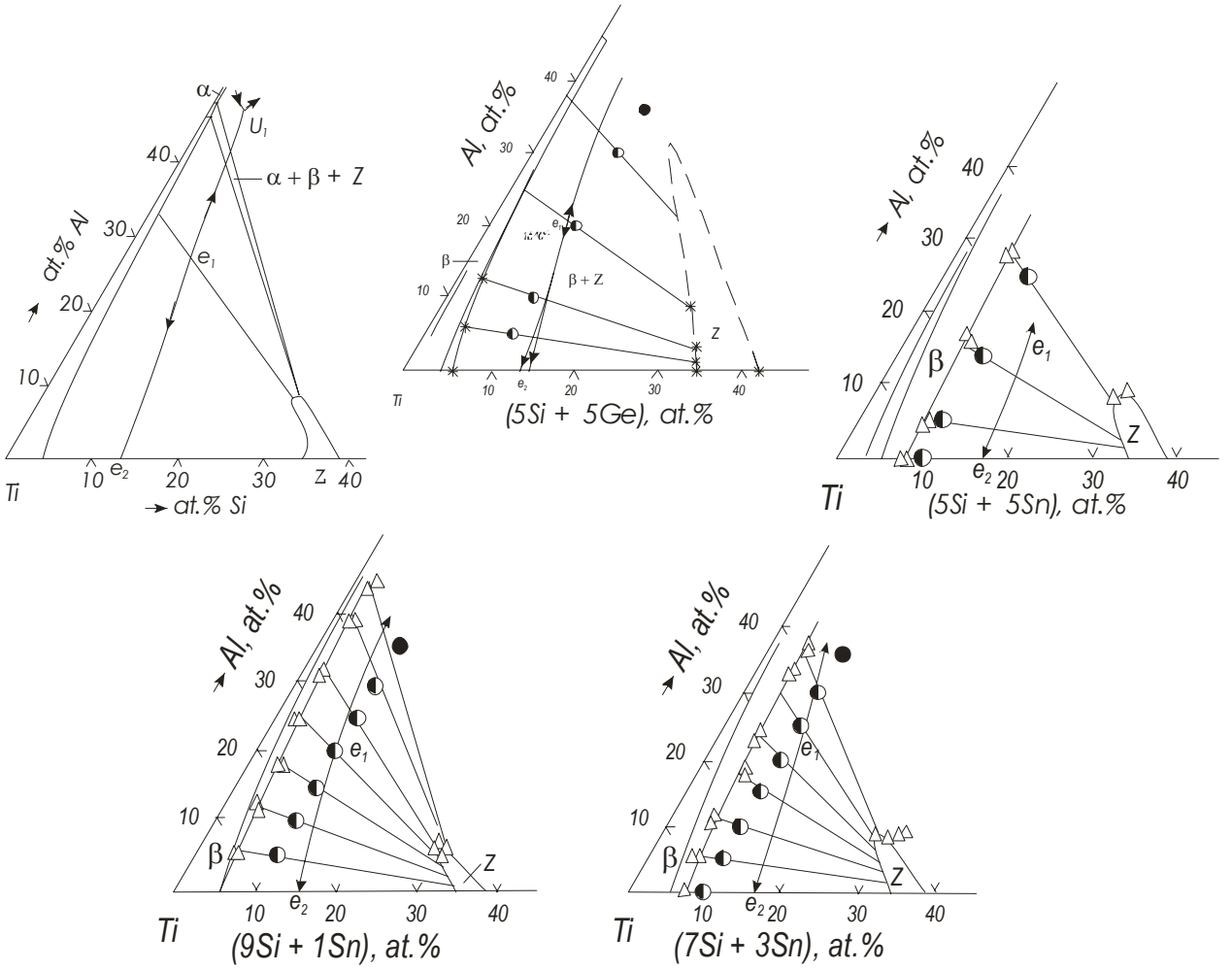

Our prognosis



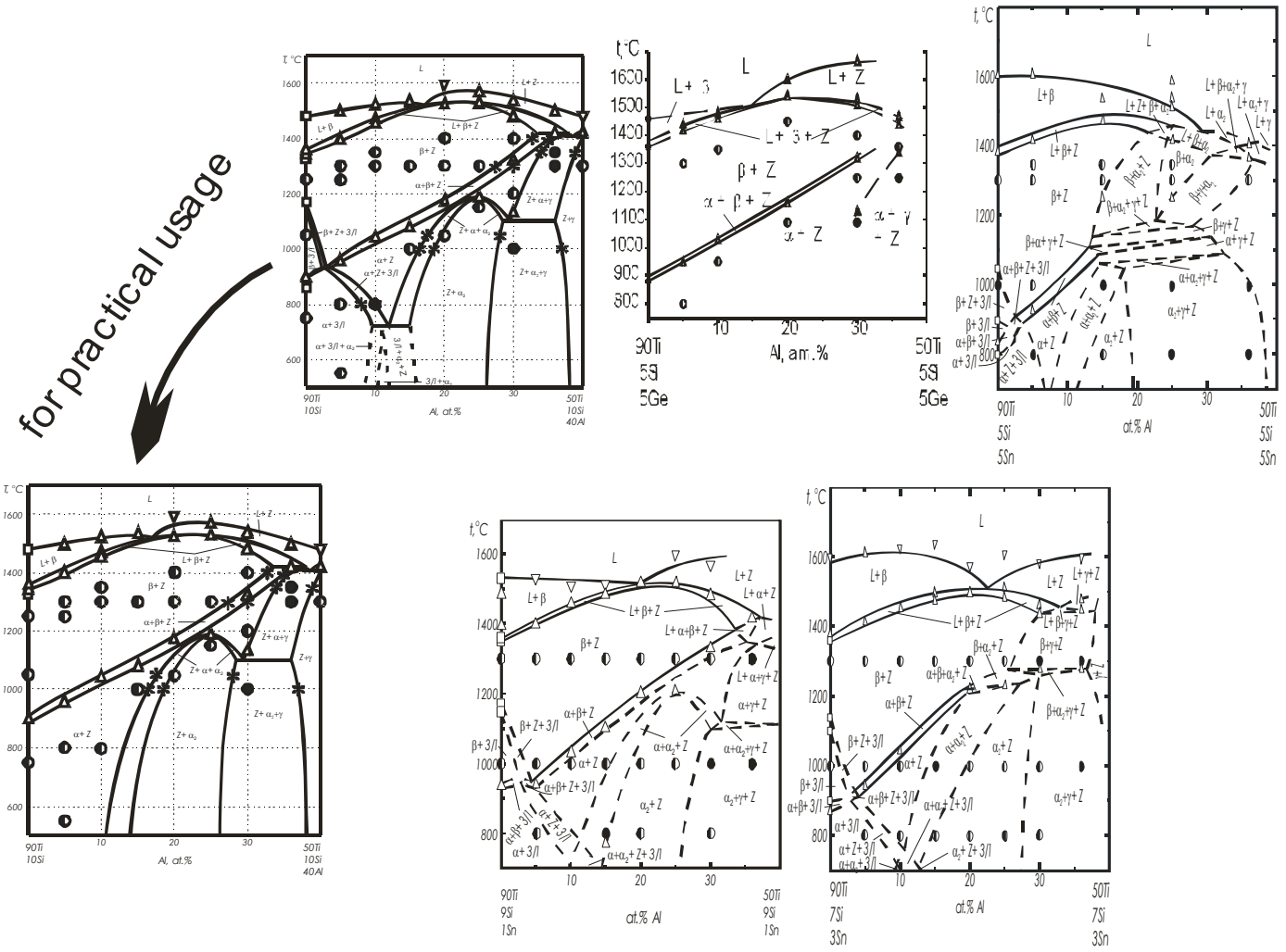

M.Bulanova et. al, 2002, to be published



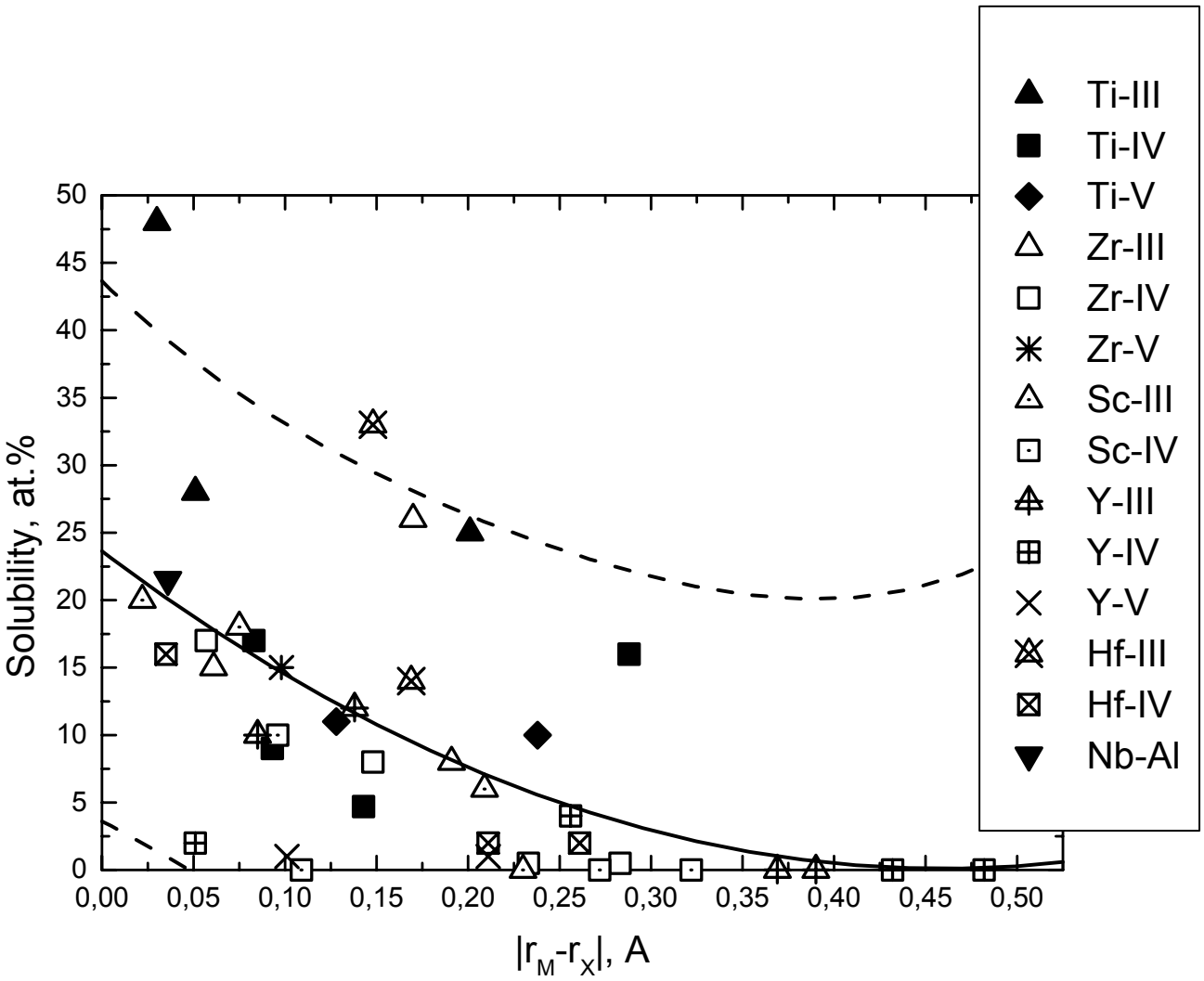
# Melting diagrams of Ti- corners of Ti-Si-Al-p-element systems



# Isopleths of Ti-corners of Ti-Si-Al-p-element systems



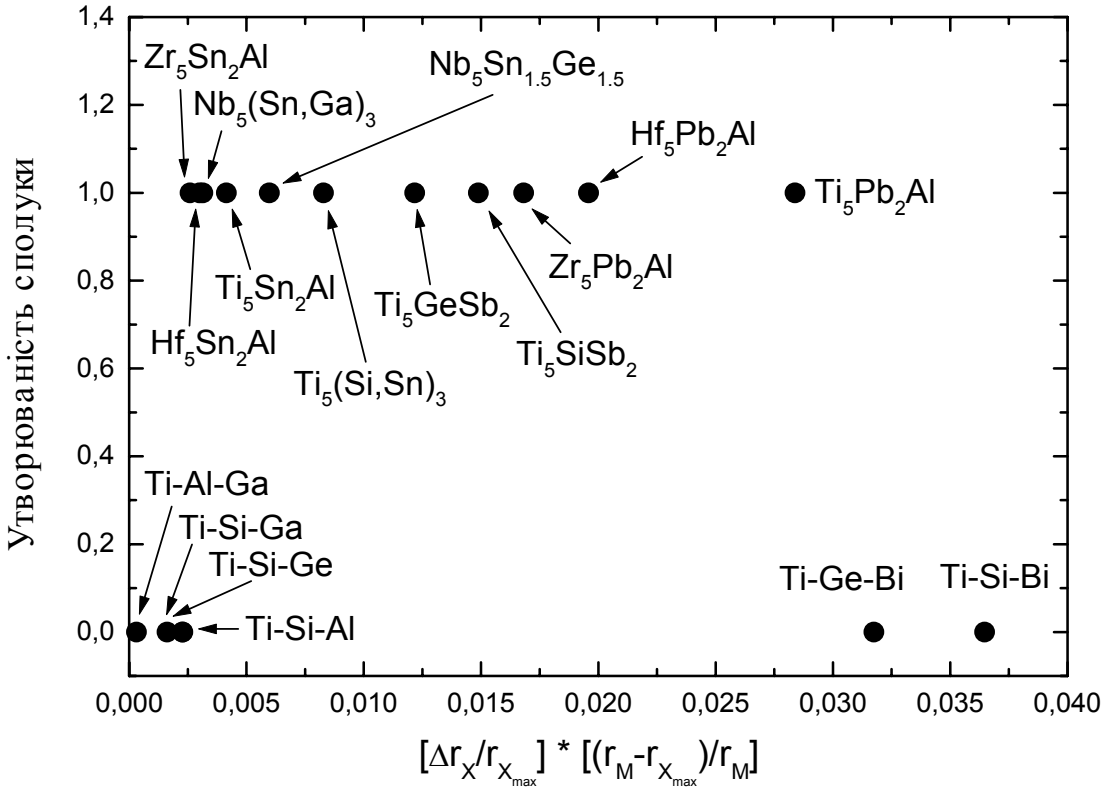
# Maximum solubility of *p*-elements in *d*-metals



# Formability of the 5/3 ternary compounds with the $W_5Si_3$ structure type

$$F = [\Delta r_X / r_{Xmax}] * [(r_M - r_{Xmax})/r_M]$$

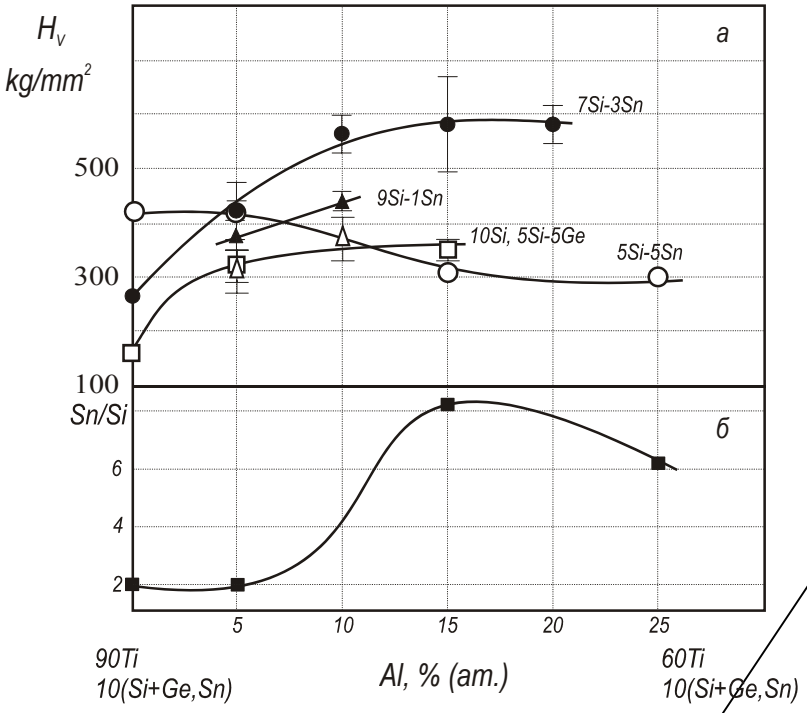
$\Delta r_X$ – difference of the atomic radii of *p*-elements,
$r_{Xmax}$ – atomic radius of the larger *p*-element atom,
$r_M$ – atomic radius of *d*-metal.

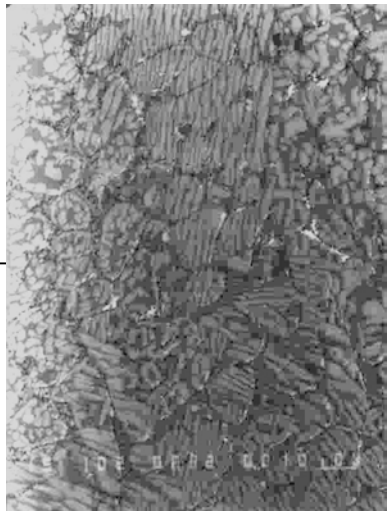



$0.023 < F < 0.032$.

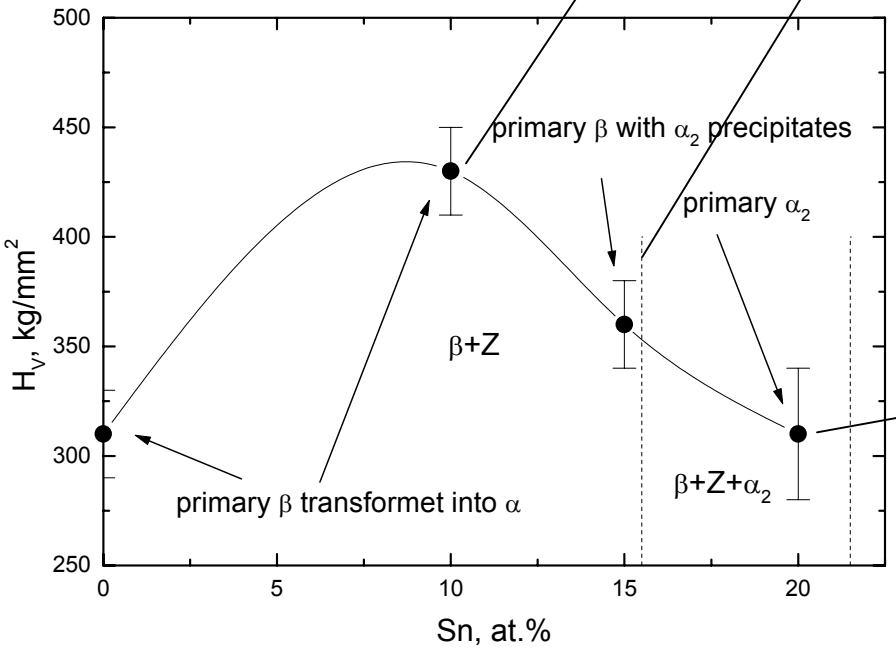
# Microhardness of Ti-matrix

## M.Bulanova et. al, 1998, 2000

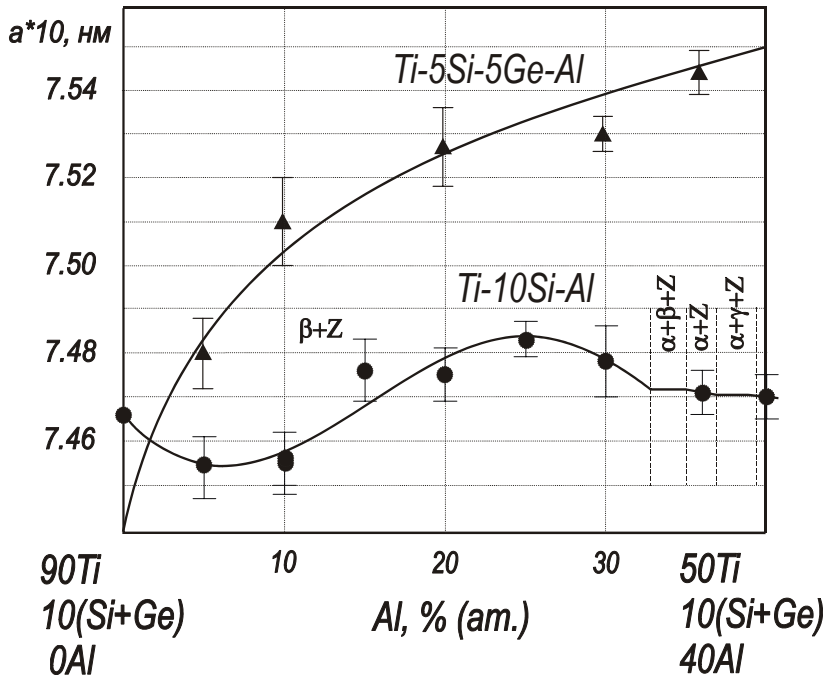


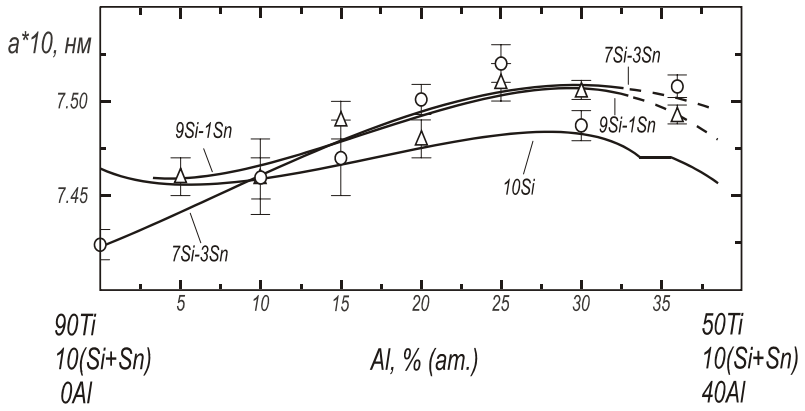



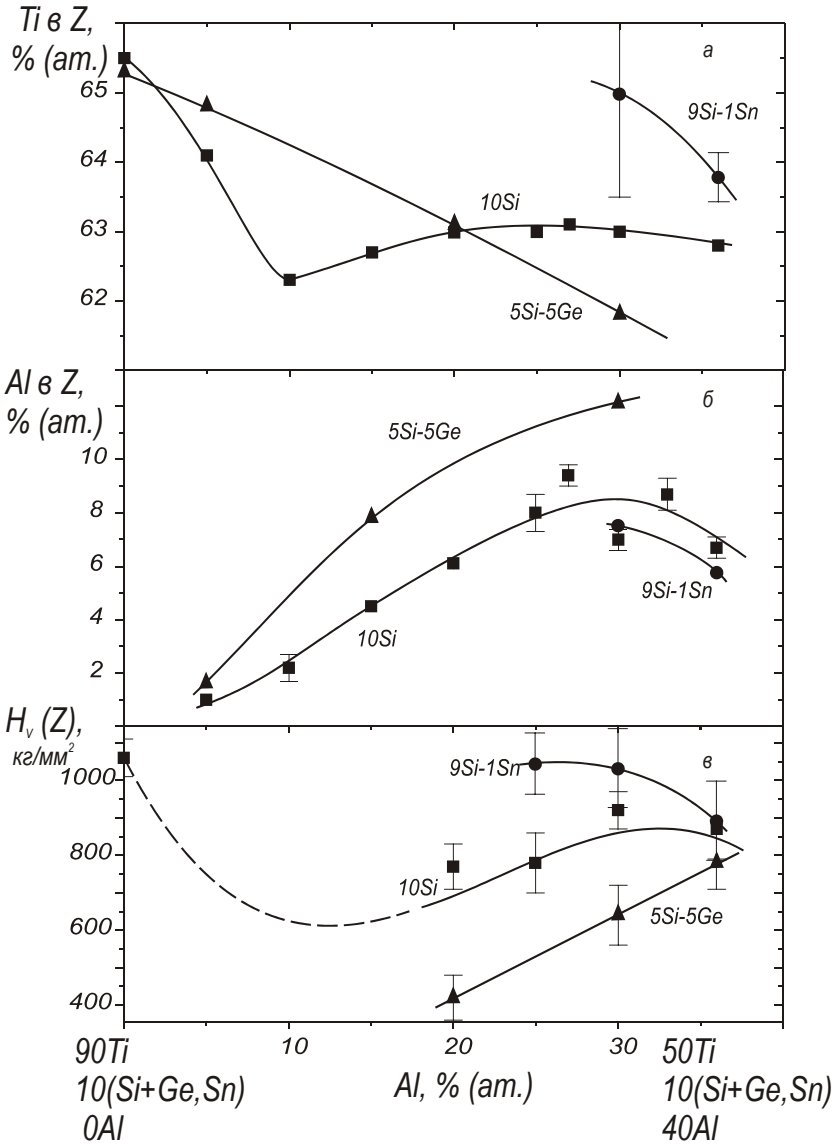
## M.Bulanova et al., 2003



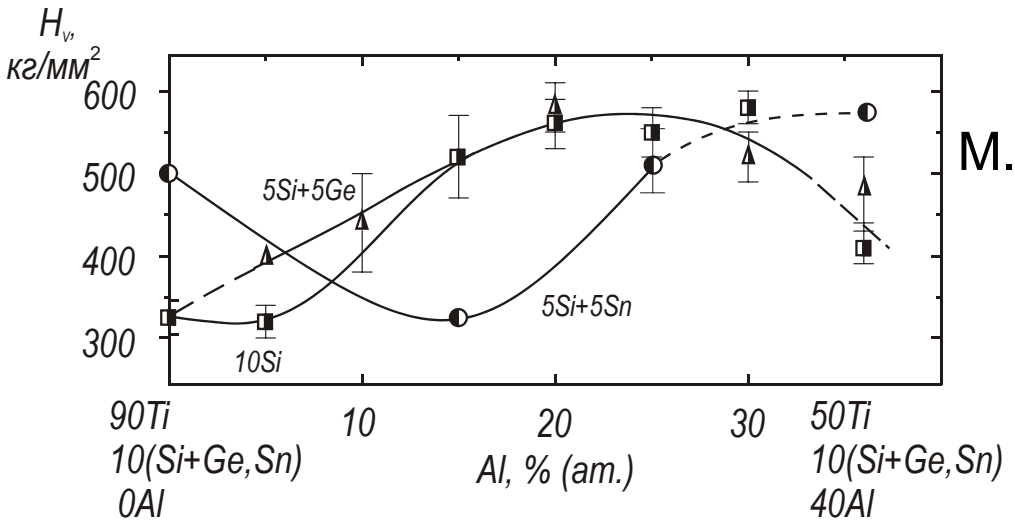

# Lattice spacings and microhardness of the primary Z



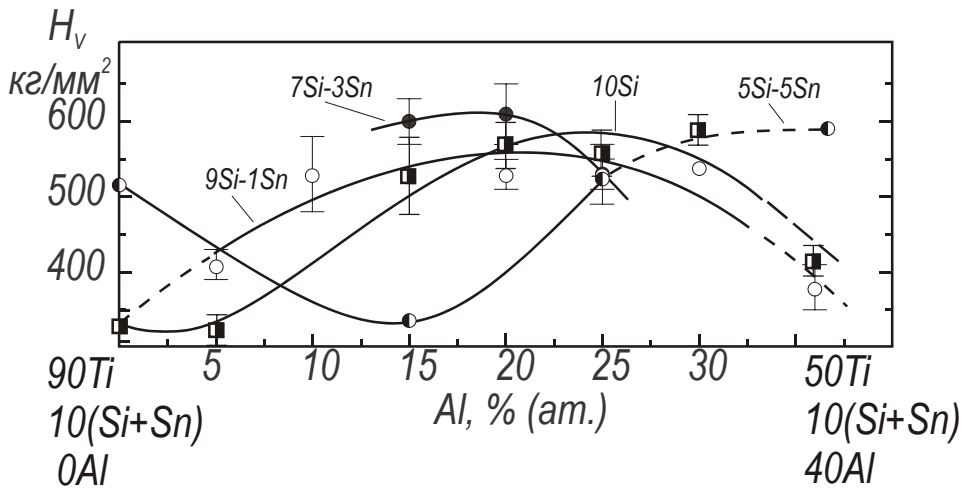



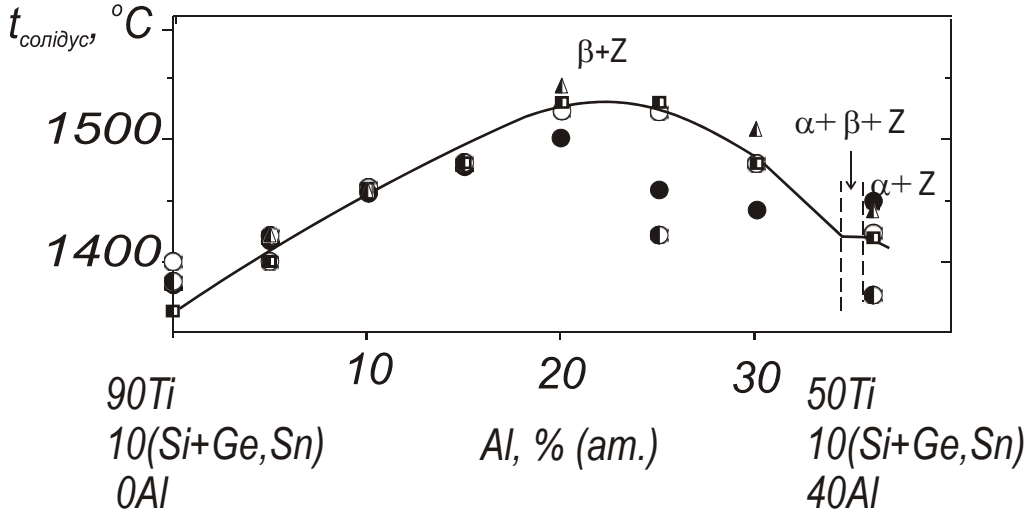



# Correlation of microhardness of eutectic mixtures with the solidus temperatures



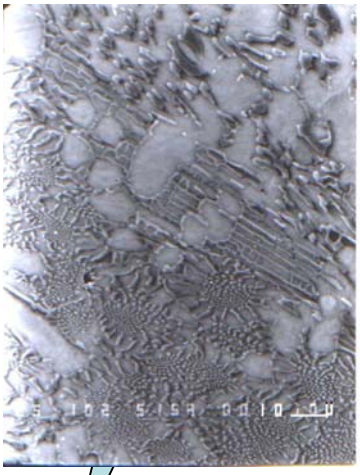

M.Bulanova et. al, 1998, 2000

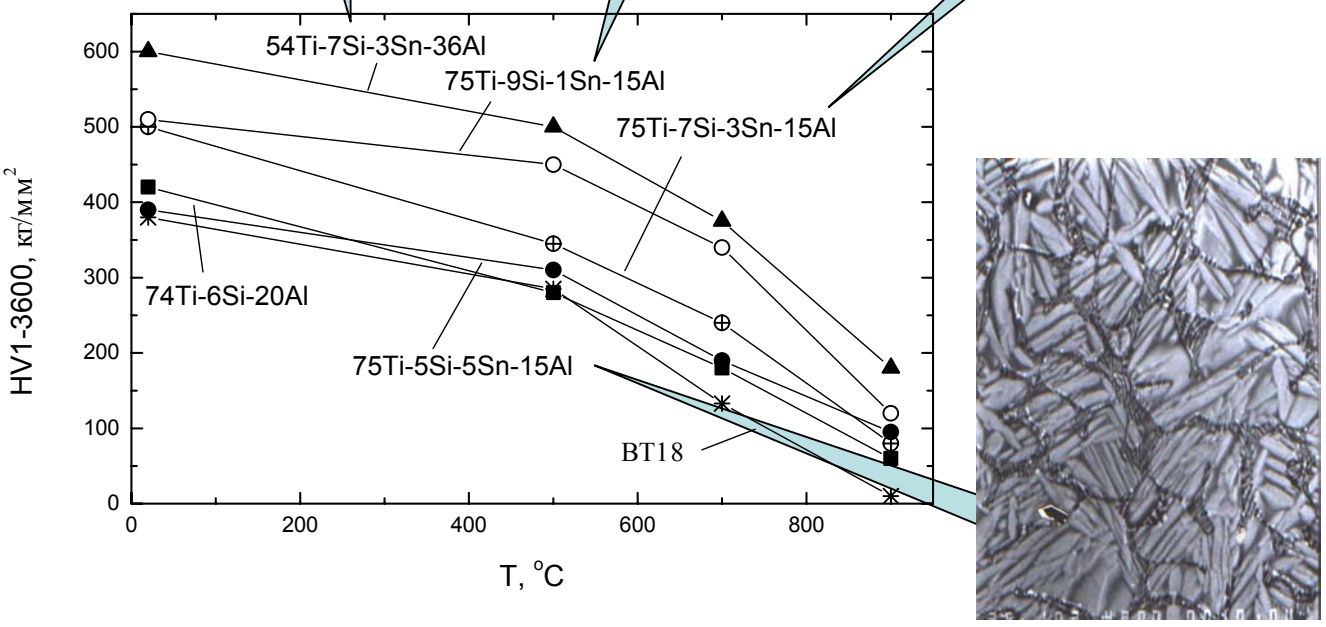


# Long-term hot hardness of Ti-Si-Sn-Al alloys

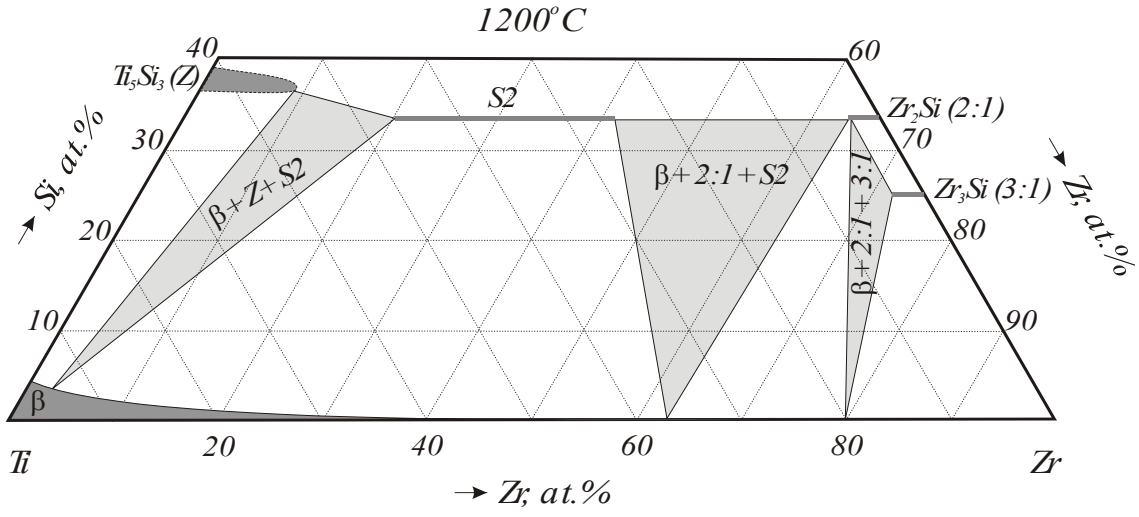
Data obtained by Dr. O.Ban'kovsky



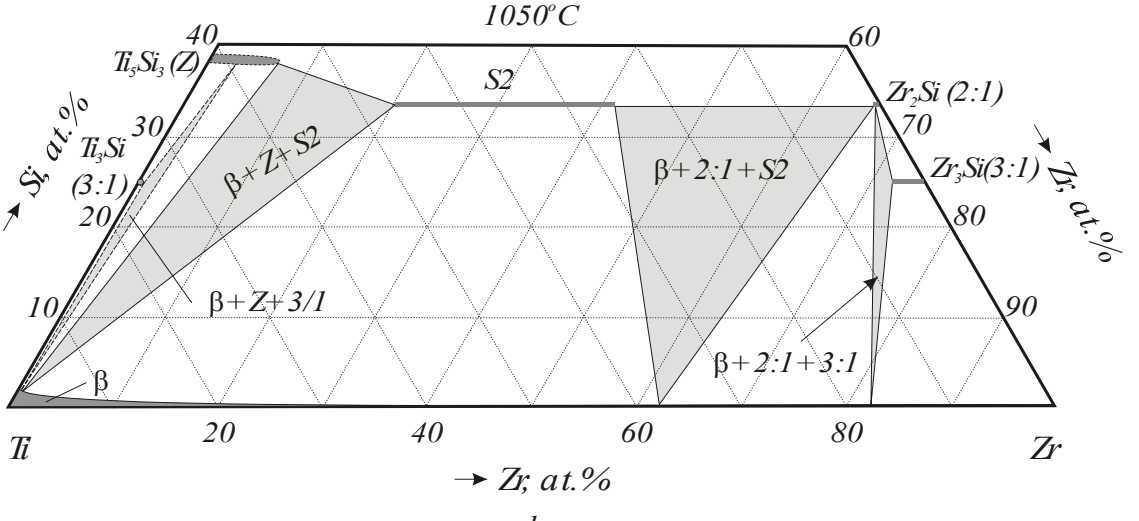


# Isothermal sections of the Ti-Zr-Si system

## N.H.Salpadoru et. al, 1995



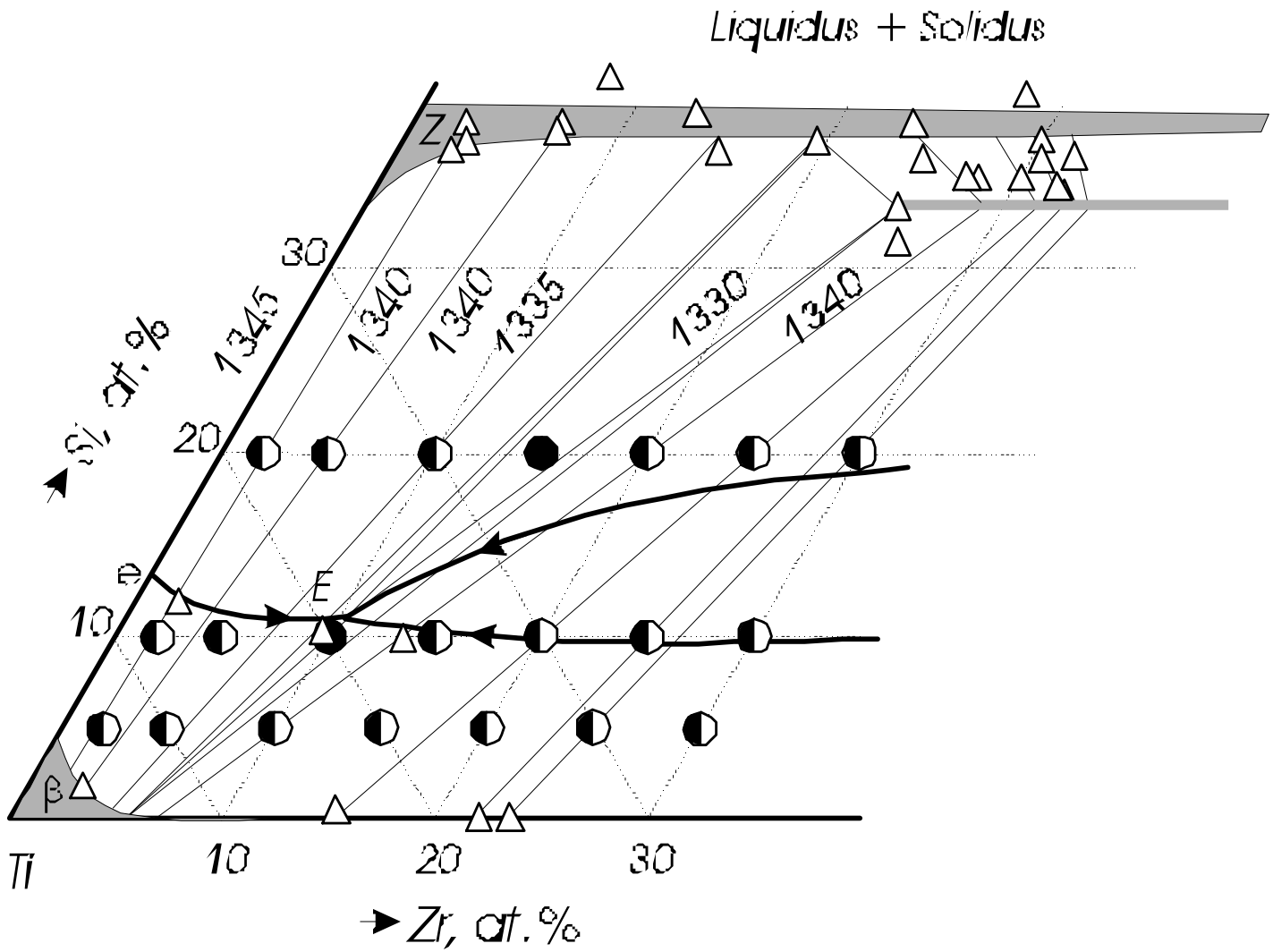

*a*




*b*

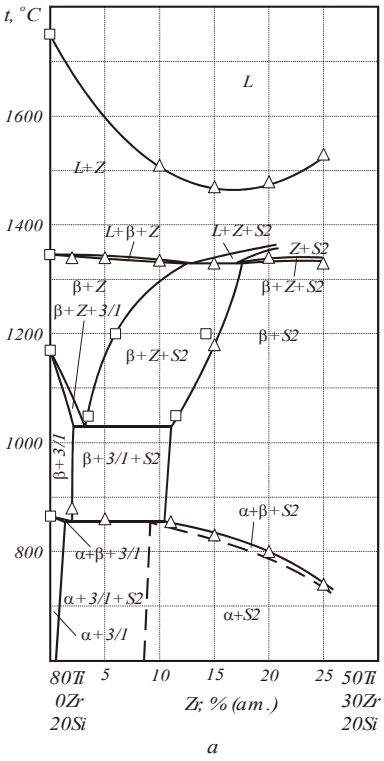
# Ti-corner of the Ti-Zr-Si melting diagram

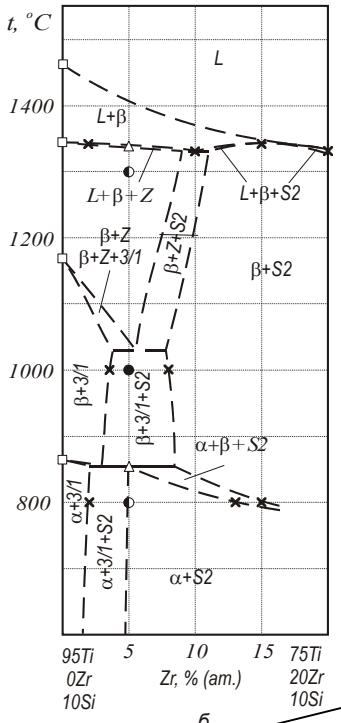
## our data



# Isopleths and some properties of Ti-Zr-Si alloys

M.Bulanova et. al, to be published

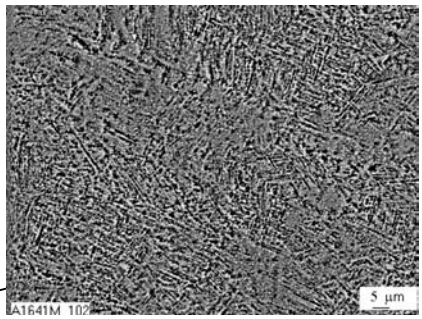


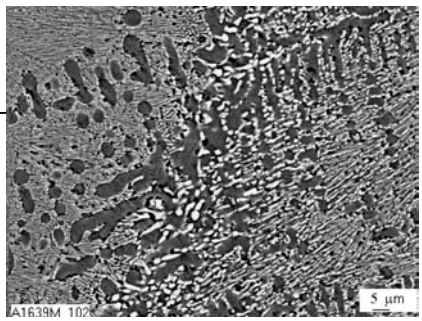



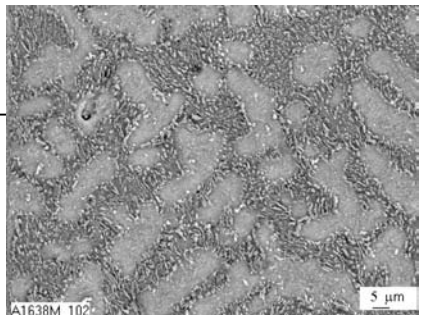

## Two factors in competition

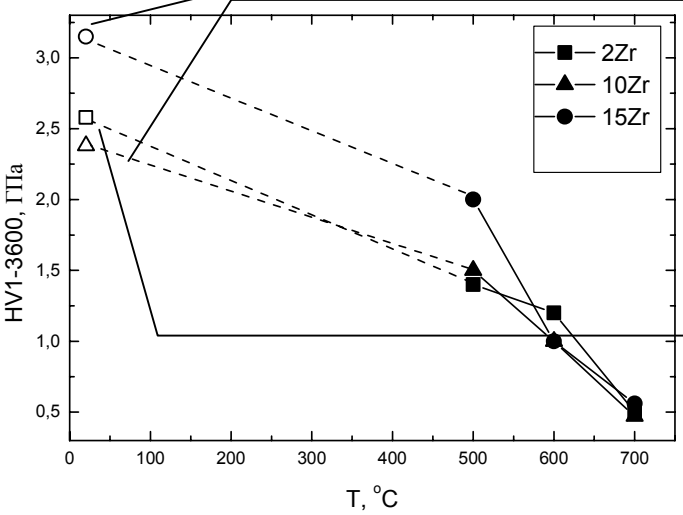
– dispersity of the structure

– the temperature

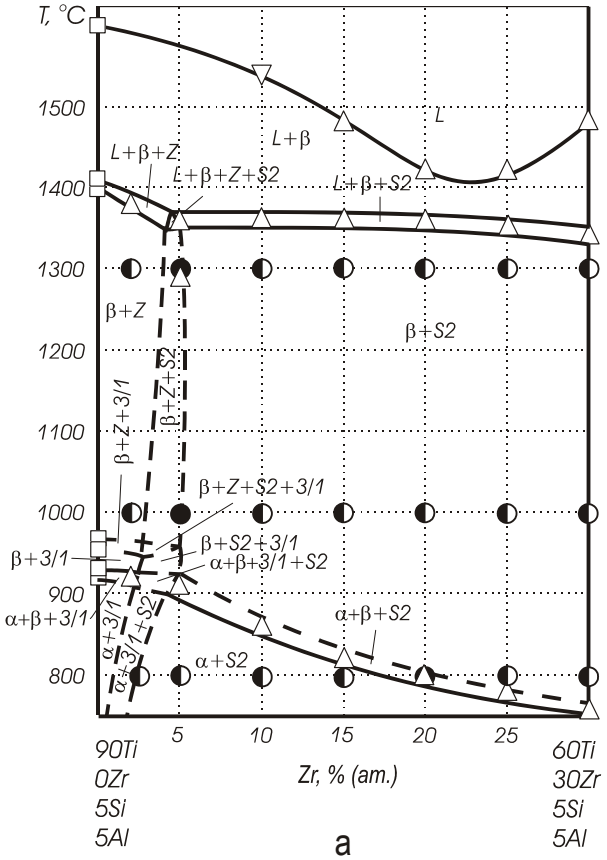


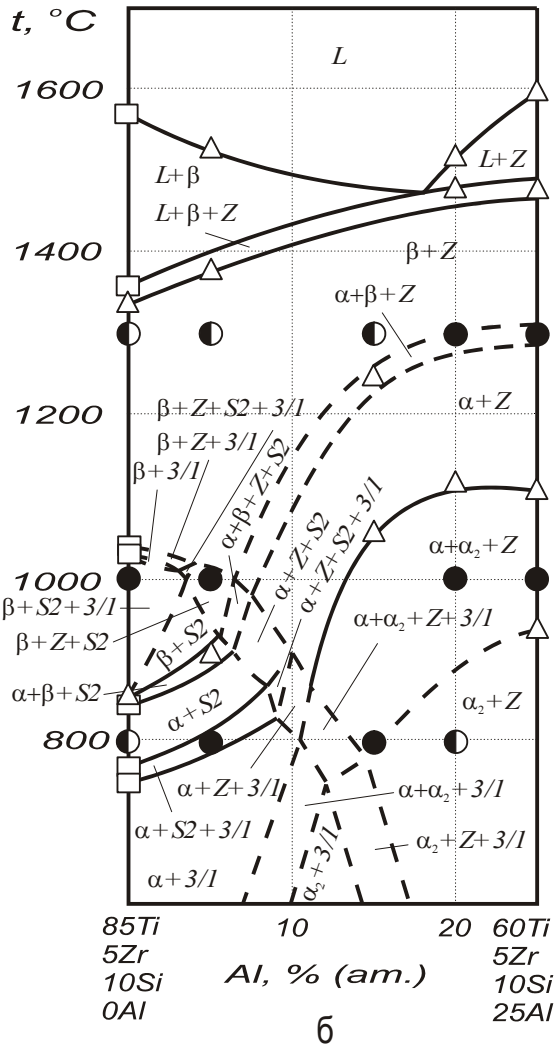



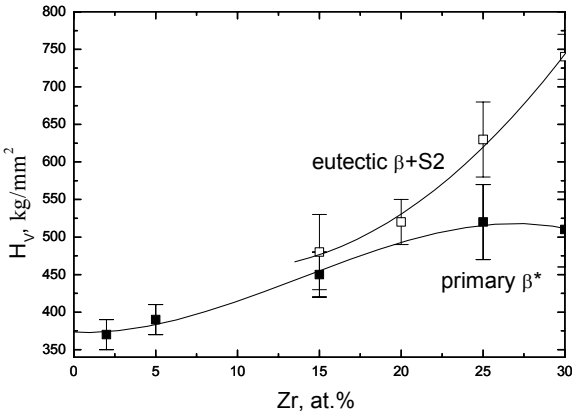



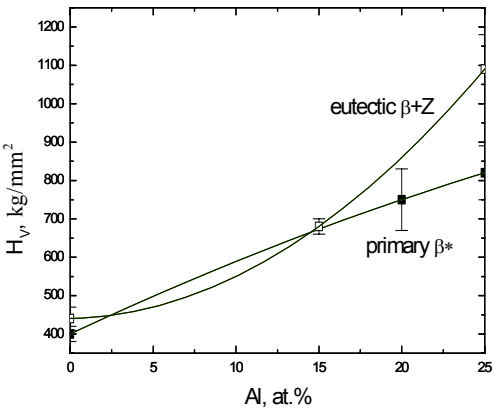



# Isopleths and microhardness of the Ti-Zr-Si-Al alloys

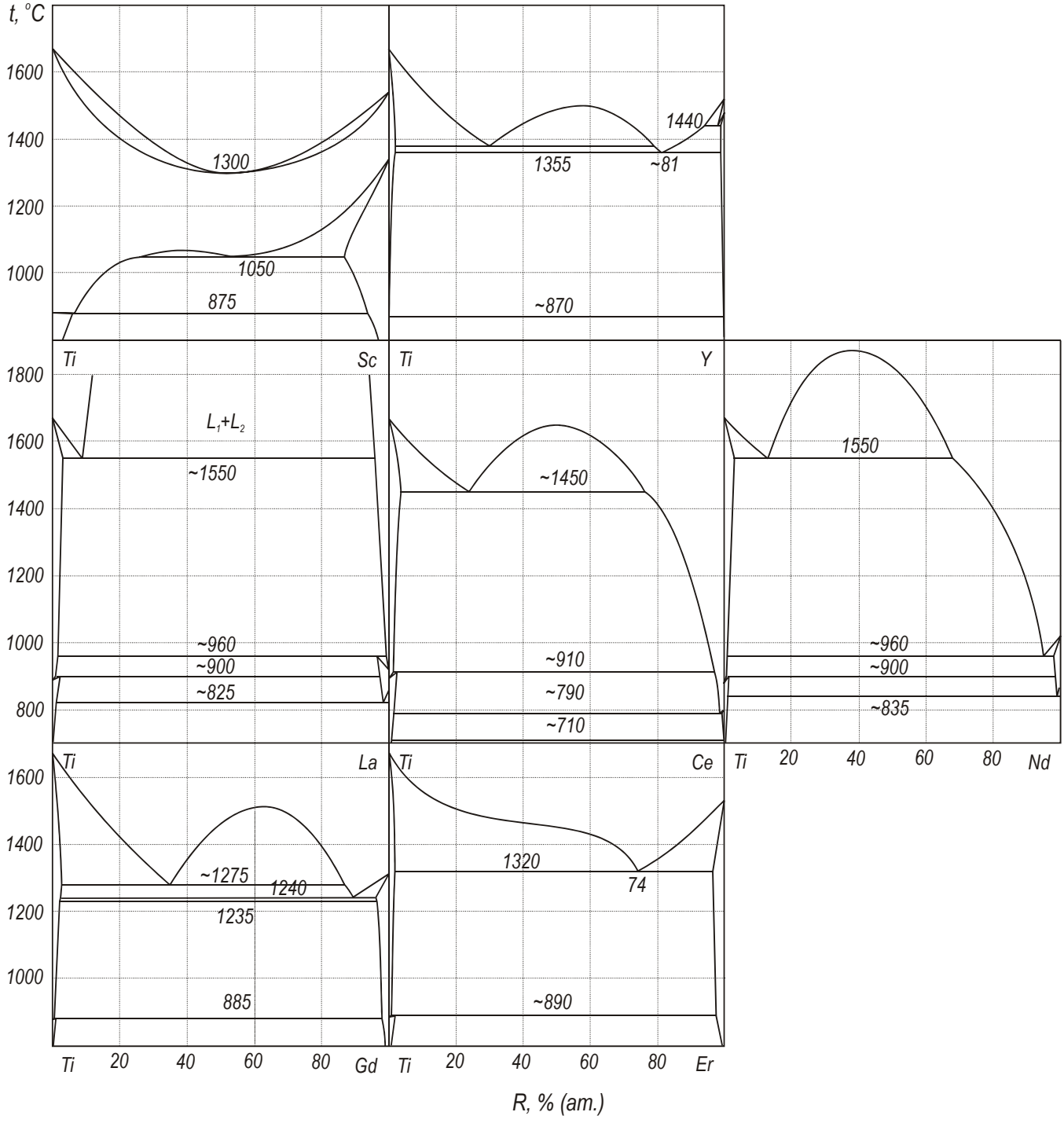


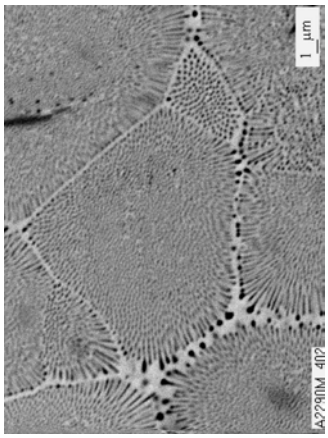



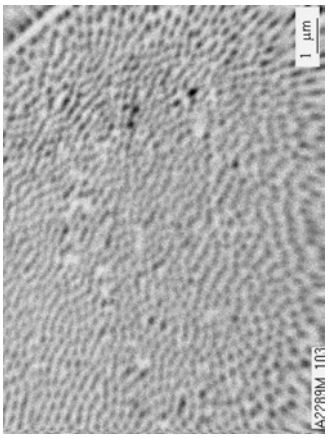
# Ti-R phase diagrams from [T.Massalski2]

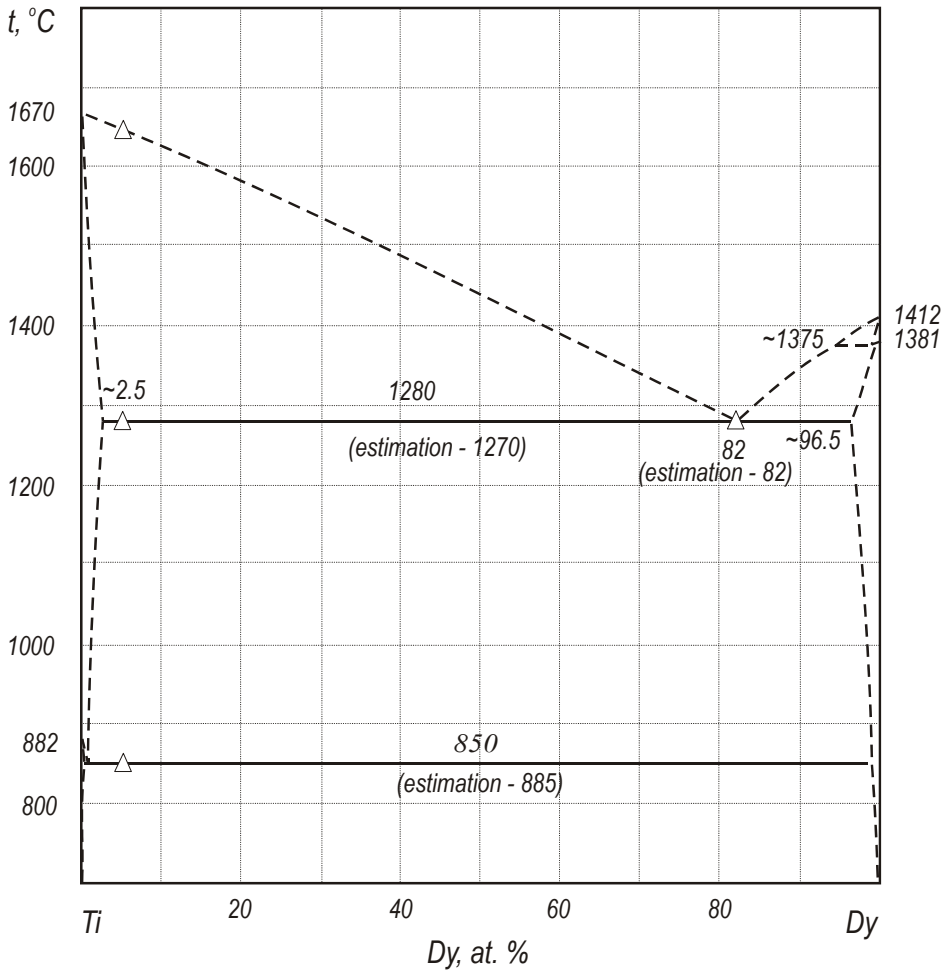


# Ti-Dy phase diagram

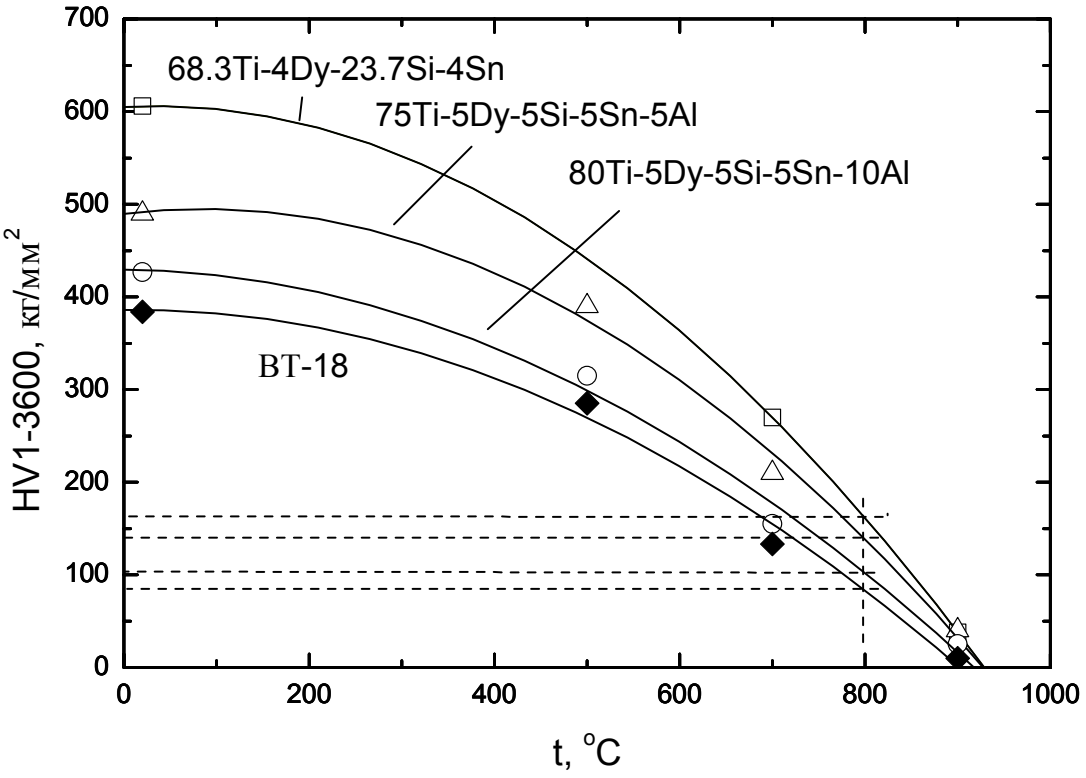
M.Bulanova et. al, 2003, to be published







# Long-term hot hardnes of Ti-Dy-Si-Sn-Al alloys



# General conclusions

- For the practical usage phase fields with participation of the $Ti_3Si$-phase can be ignored

- Understanding of the relations of the details of phase diagrams, crystal structure of the phases and metal chemistry of the components on the one hand and mechanical properties of the phases and materials in the whole on the other hand is absolutely necessary for effective process of materials elaboration